Markets and Reliability: Operating Reserve and Reliability Deployment Price Adders

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Market Analysis and Validation

ERCOT Public
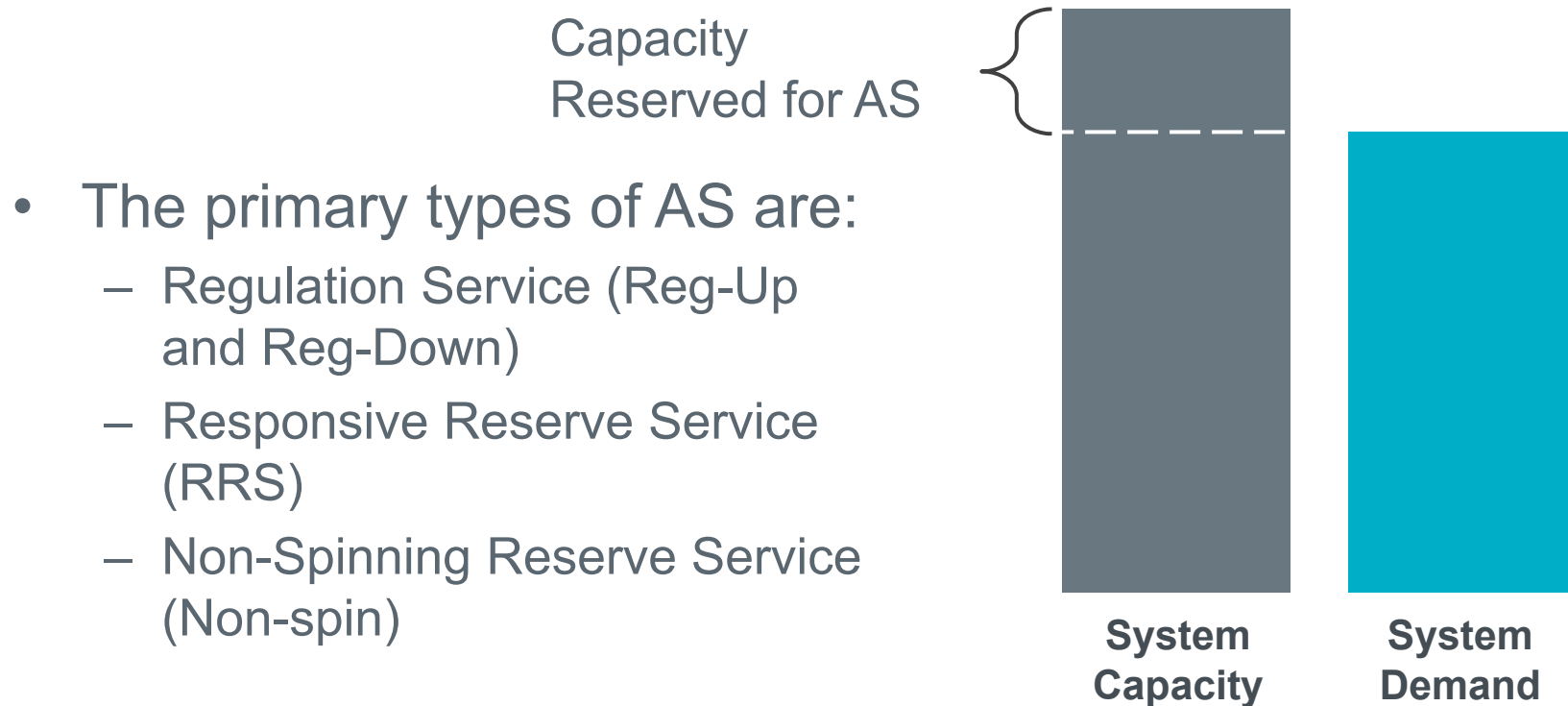2018 ERCOT Operator Training Seminar

Objectives

1. Describe how the operating reserve and reliability deployment prices adders are incorporated into real-time prices

2. Explain the purpose of the prices adders

3. Recognize system conditions under which there is a potential for non-zero price adders

4. Identify what the historical, typical prices adders have been

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Agenda

- Real-Time On-Line Price Adders and Off-Line Reserve Price Adders (RTORPA and RTOFFPA)

  - Refresher on Ancillary Services and how do they compare to operating reserves

  - What are they and why were they implemented?

  - How are they calculated?

- The Real-Time On-Line Reliability Deployment Price Adder (RTORDPA)

  - What do we mean by reliability deployments?

  - What is it and why was it implemented?

  - How it is calculated?

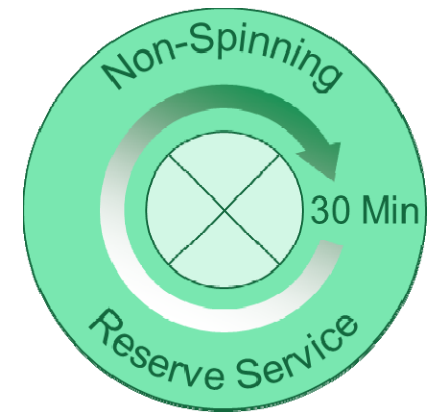- What have the historical results of the price adders been?
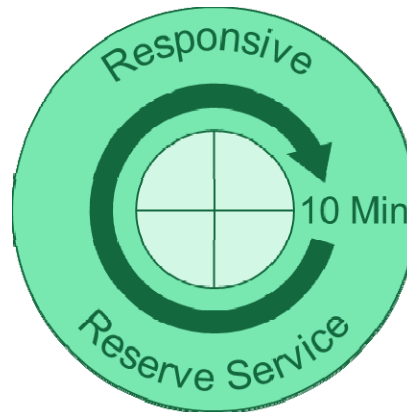
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Ancillary Services

- An Ancillary Service (AS) is a reliability service procured by ERCOT and is capacity that is reserved on Resources to allow ERCOT to respond quickly to changing system conditions.

Capacity
Reserved for AS

- The primary types of AS are:
  - Regulation Service (Reg-Up and Reg-Down)
  - Responsive Reserve Service (RRS)
  - Non-Spinning Reserve Service (Non-spin)

System Capacity

System Demand

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Ancillary Service Products by Resource Type

- ## Who carries what?

Regulation Down / 60.000 / Regulation Up	Responsive Reserve Service 10 Min	Non-Spinning Reserve Service 30 Min
On-line Generation Resources	On-line Generation Resources	Off-line Generation Resources
Controllable Load Resources	Controllable Load Resources	On-line Generation Resources
Wholesale Storage Loads	Load Resources on Under-Frequency Relay	Controllable Load Resources

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Regulation Service

Provides capacity that can respond to signals from ERCOT within seconds to maintain system frequency

**Two Types of Regulation Service**

- Reg-Up

- Reg-Down

Must be capable of ramping through reserved capacity in 5 minutes

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Responsive Reserve Service

Provides capacity reserves intended to:

- Respond to significant frequency deviations

- Serve as backup Regulation

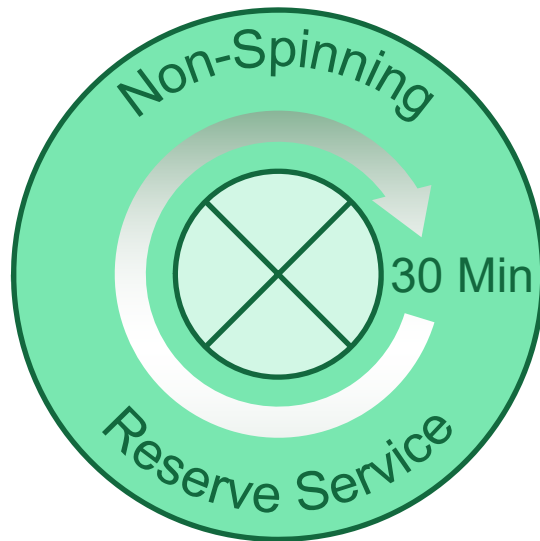- Provide additional capacity during an Energy Emergency Alert (EEA)

Must be capable of ramping through reserved capacity in 10 minutes

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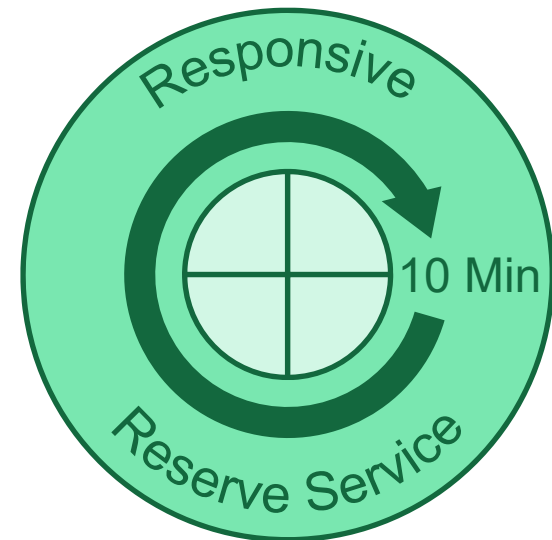
Non-Spinning Reserve Service

Provides additional capacity reserves that can be utilized within 30 minutes

Uses

- System-Wide capacity needs

- Local capacity needs

- Recover Responsive Reserve Service in a timely manner

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Ancillary Services vs. Operating Reserves

- These AS are cleared in the DAM or Supplemental AS Market (SASM) and have specific rules on how they are utilized.

- Operating reserves refers more generally to the extra capacity that is available in real-time and includes:

  – AS that has not been deployed

  – Headroom on Resources that are not providing AS

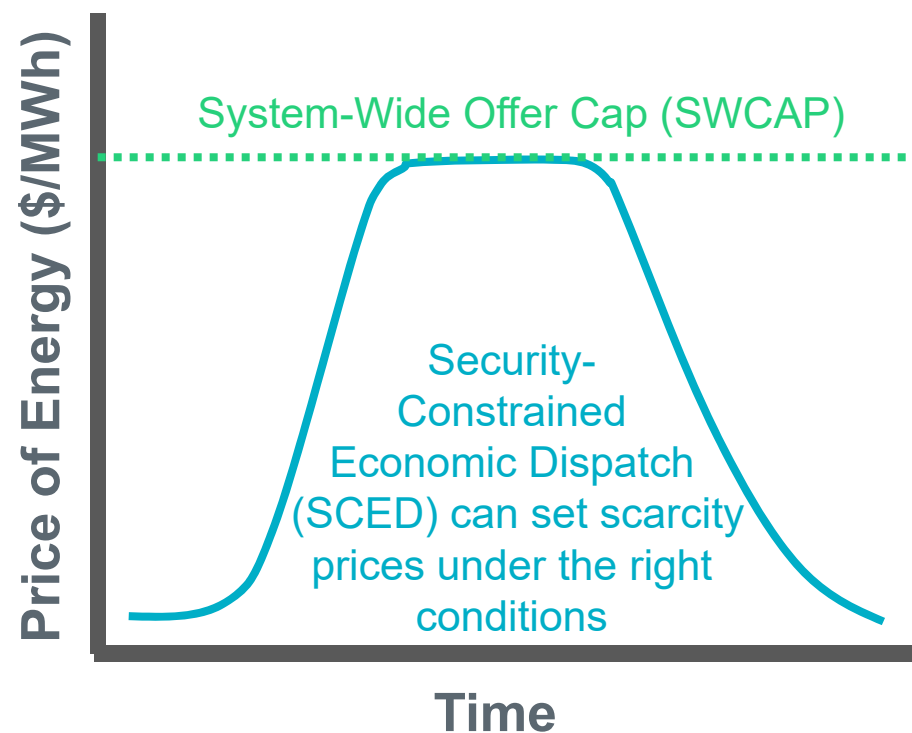 – Extra headroom on Resources that are providing AS

> We'll come back to the definition and categories of operating reserves later.

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Scarcity Pricing

ERCOT is an energy-only market

Energy pricing must support an appropriate level of investment in Resources

- When operating reserves are low, the probability of having a scarcity event increases.

- If the scarcity event is severe, ERCOT may need to shed load.

- System prices should reflect the **value** of available reserves, since reserves reduce the chance that ERCOT will have to shed load.

System-Wide Offer Cap (SWCAP)

Security-Constrained Economic Dispatch (SCED) can set scarcity prices under the right conditions

Price of Energy ($/MWh)

Time

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The Value of Operating Reserves

- In the early years of the Nodal Market, higher prices during times of scarcity had to be driven by higher priced Energy Offer Curves.

- This dependency on higher priced Energy Offer Curves can fail to recognize the value that diminishing real-time reserves provide in avoiding potential load-shedding events on the system.
  - RTORPA and RTOFFPA are intended to better represent this value of the real-time reserves.

- After the addition of RTORPA, energy prices approximate the outcome of real-time energy and AS co-optimization.
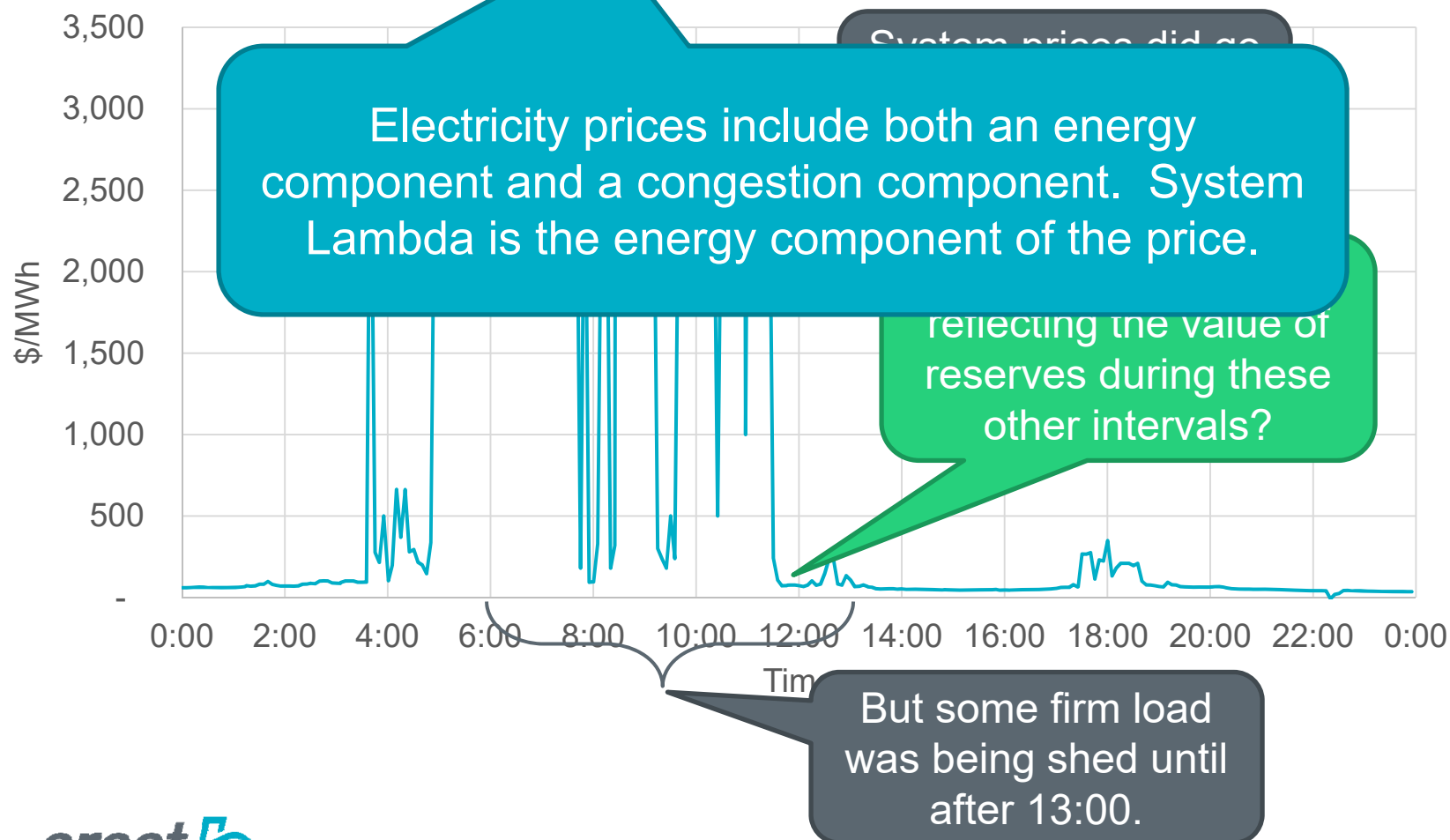
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The Value of Operating Reserves

- The overall goal is to improve scarcity pricing

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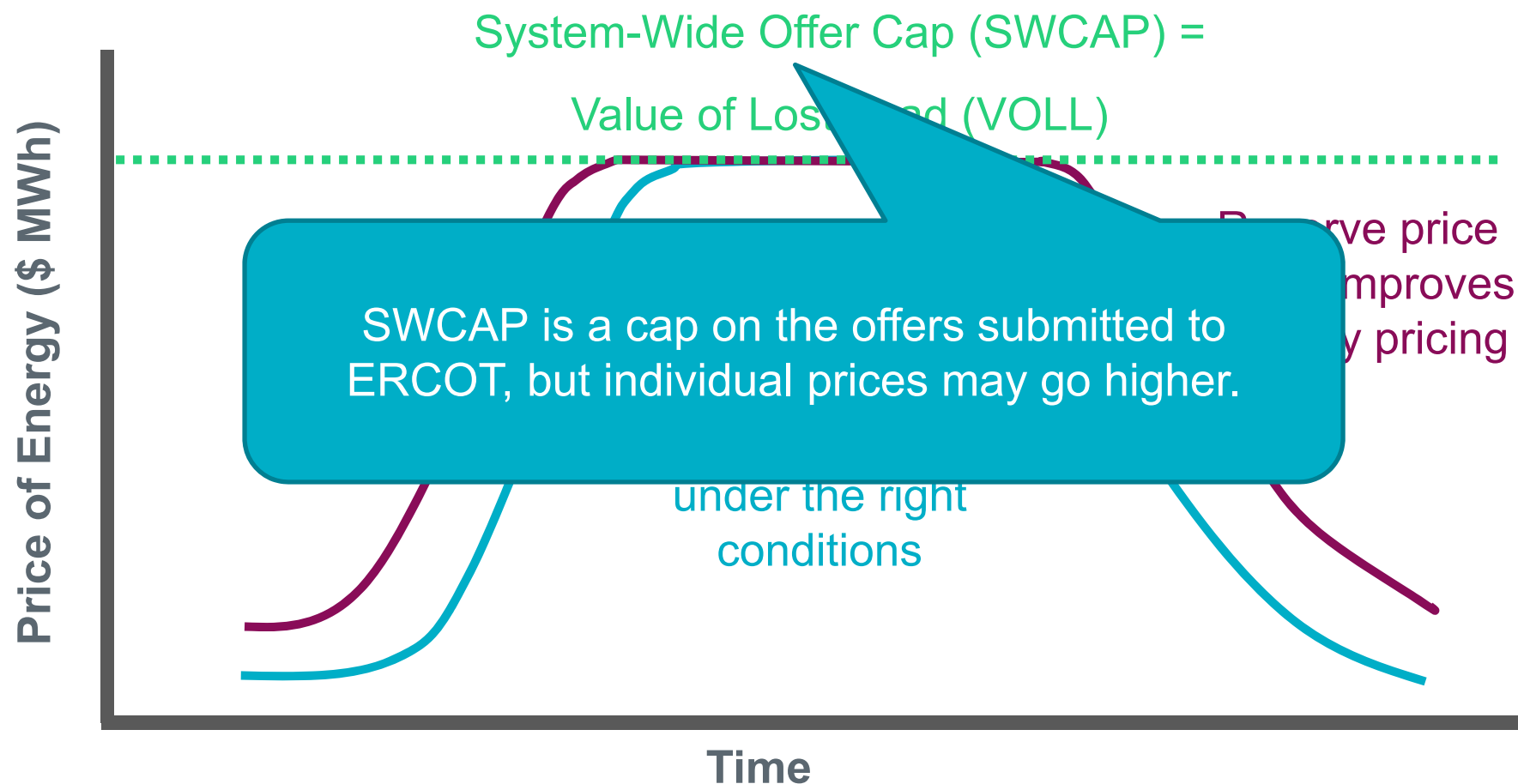
Real-Life Example from 2011

Real-Time Market System Lambda on February 2nd, 2011

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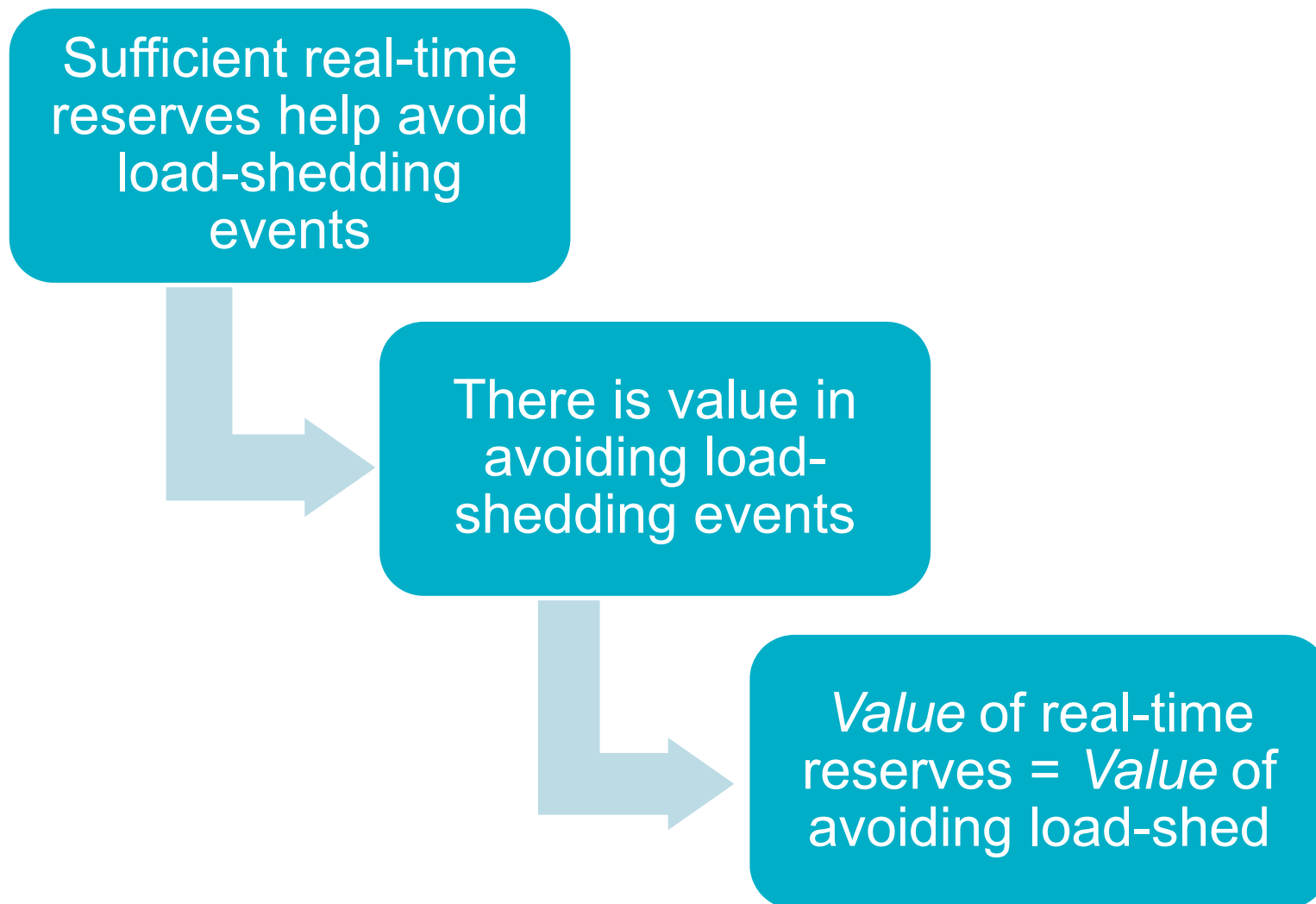
The Value of Operating Reserves

RTORPA

- Represents the value of the Real-Time On-Line Reserve Capacity (RTOLCAP) being provided by Qualified Scheduling Entities (QSEs)
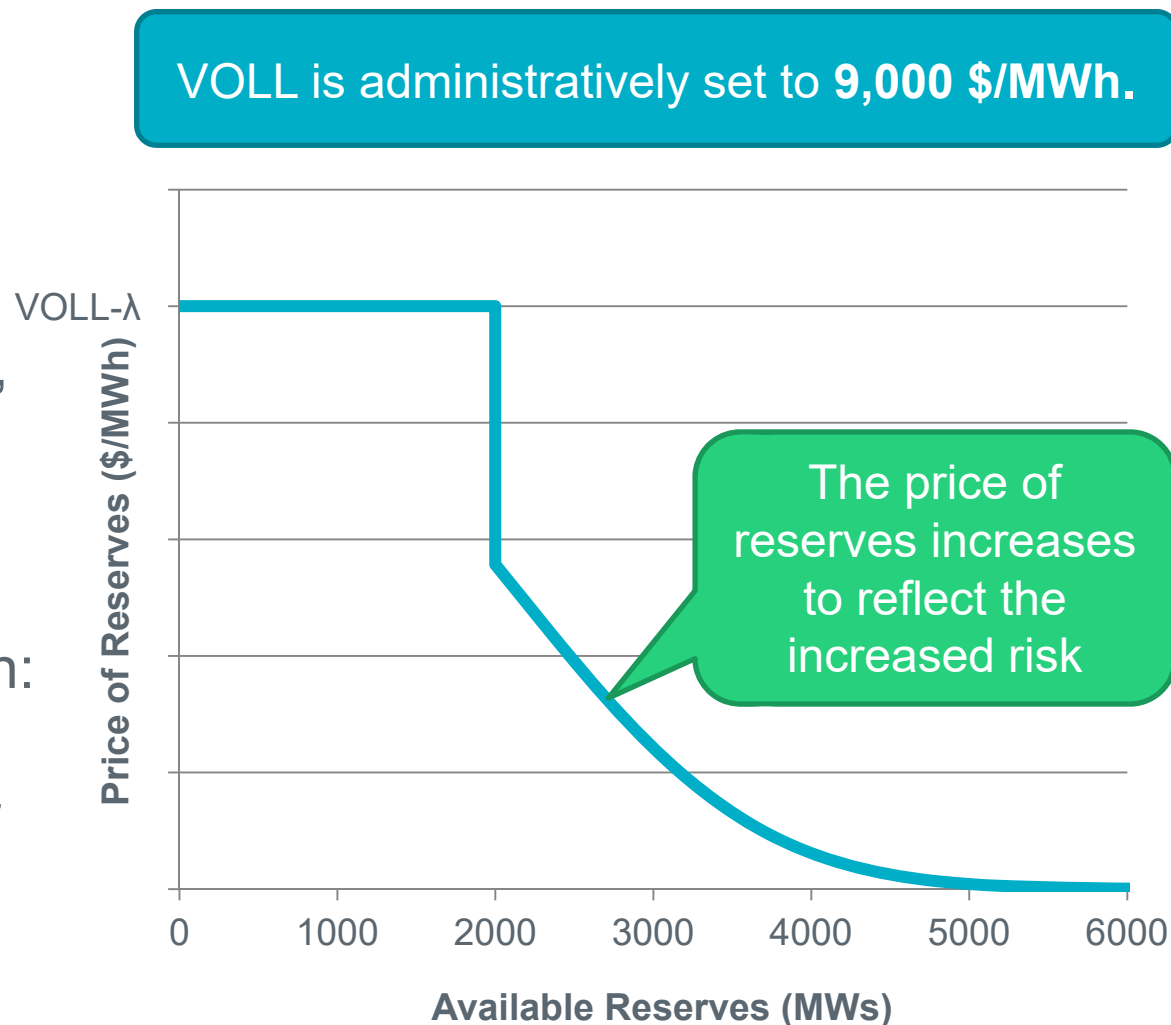 - Capacity able to respond immediately following an event

RTOFFPA

- Represents the value of the Real-Time Off-Line Reserve Capacity (RTOFFCAP) being provided by QSEs
  - Capacity not currently available but could be in 30 minutes

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How Do You Determine that Value?

Sufficient real-time reserves help avoid load-shedding events

There is value in avoiding load-shedding events

Value of real-time reserves = *Value* of avoiding load-shed

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The Operating Reserve Demand Curve

- ERCOT implemented an Operating Reserve Demand Curve (ORDC) on June 1, 2014.

- Reserve prices should be based on:
  - VOLL
  - The probability of shedding load

VOLL is administratively set to **9,000 $/MWh.**

The price of reserves increases to reflect the increased risk

VOLL-λ

Price of Reserves ($/MWh)

Available Reserves (MWs)

0   1000   2000   3000   4000   5000   6000

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Creating the Operating Reserve Demand Curve

- ORDC constructed as the product of:
  - The probability of reserves falling below the minimum contingency level (PBMCL)
  - The difference between VOLL and System Lambda

- The distribution of errors used for PBMCL is determined using historical values of:
  - Reserve capacity projected in the hour-ahead
  - Reserve capacity observed in real-time
  - Any firm load that was shed

- Hours are split into groups based on the Season and time of day

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Calculating the Reserve Price Adders

- With reserves broken up into two categories (RTOLCAP and RTOFFCAP), two separate prices have to be calculated.

- First is the calculation RTOFFPA:
  - Based on the probability of reserves falling below a minimum contingency level over an hour given the amount of reserves available in the latter 30 minutes of the hour.
    - Amount of reserves is the sum of RTOLCAP and RTOFFCAP
  - The probability value is multiplied by .5 x (VOLL-System Lambda), reflecting that the reserves are only available for half of the hour.
  - The minimum contingency value is administratively set at 2,000 MW.

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Calculating the Reserve Price Adders

- Once RTOFFPA is known, then calculate the RTORPA:
  - Based on the probability of reserves falling below a minimum contingency level over 30 minutes given the total amount of reserves available in the first 30 minutes of the hour.
    - Amount of reserves is only RTOLCAP
  - The probability value is the multiplied by .5 x (VOLL-System Lambda), reflecting that 30 minute period
  - This product is then added to RTOFFPA to determine the final RTORPA

> Idea is that RTOLCAP contributes to preventing load shedding in both halves of the hour.

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Real-Time Pricing Methodology

- These price adders are determined during each SCED interval, however the impact still needs to be incorporated into the energy price.

- Locational Marginal Prices (LMPs) from SCED are then combined with the price adders to form real-time Settlement Point Prices (SPPs).

- QSEs will also be paid or charged for AS imbalances in real-time.

Resource Nodes

Load Zones

Hubs

While LMPs are location-specific, the value of reserves is ERCOT-wide

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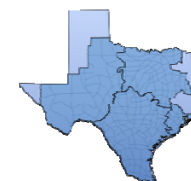
But Wait, There's One More Adder

- Reserves need to be properly valued during times of scarcity.

- It's also important to account for price distorting actions that may occur during energy scarce conditions, specifically those taken by ERCOT to maintain reliability.

  – These "reliability deployments" could be suppressing prices at the exact moment that more Resource production is needed
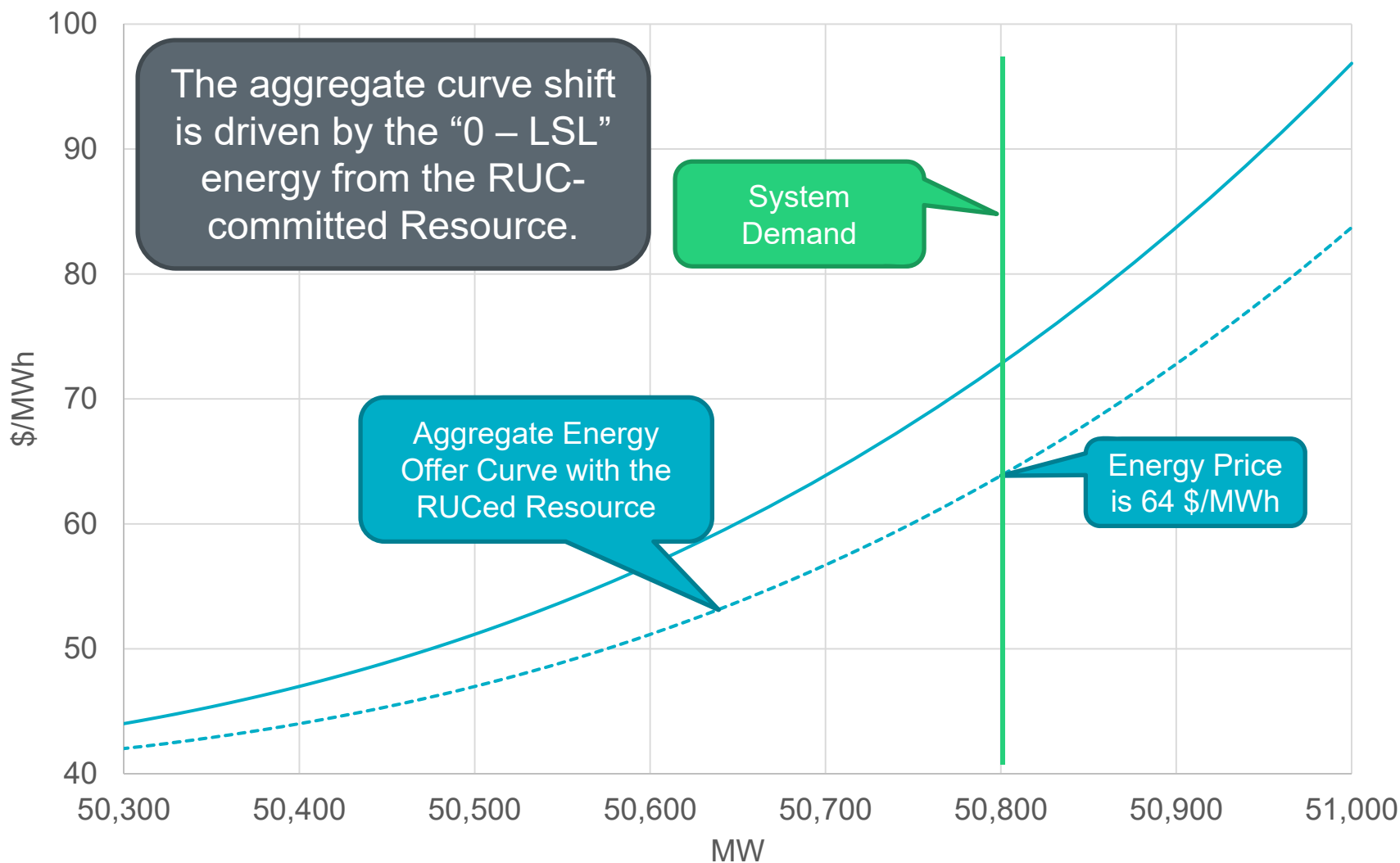
What are the Reliability Deployments?

- The commitment of Resources through Reliability Unit Commitment (RUC)
  - This would also include Reliability Must Run (RMR) Resources or Resources contracted for capacity.
  - Relaxes the low limits to negate the impact of the "price-taking" capacity
- Deployment of Load Resources other than Controllable Load Resources
- Deployment of Emergency Response Service (ERS)

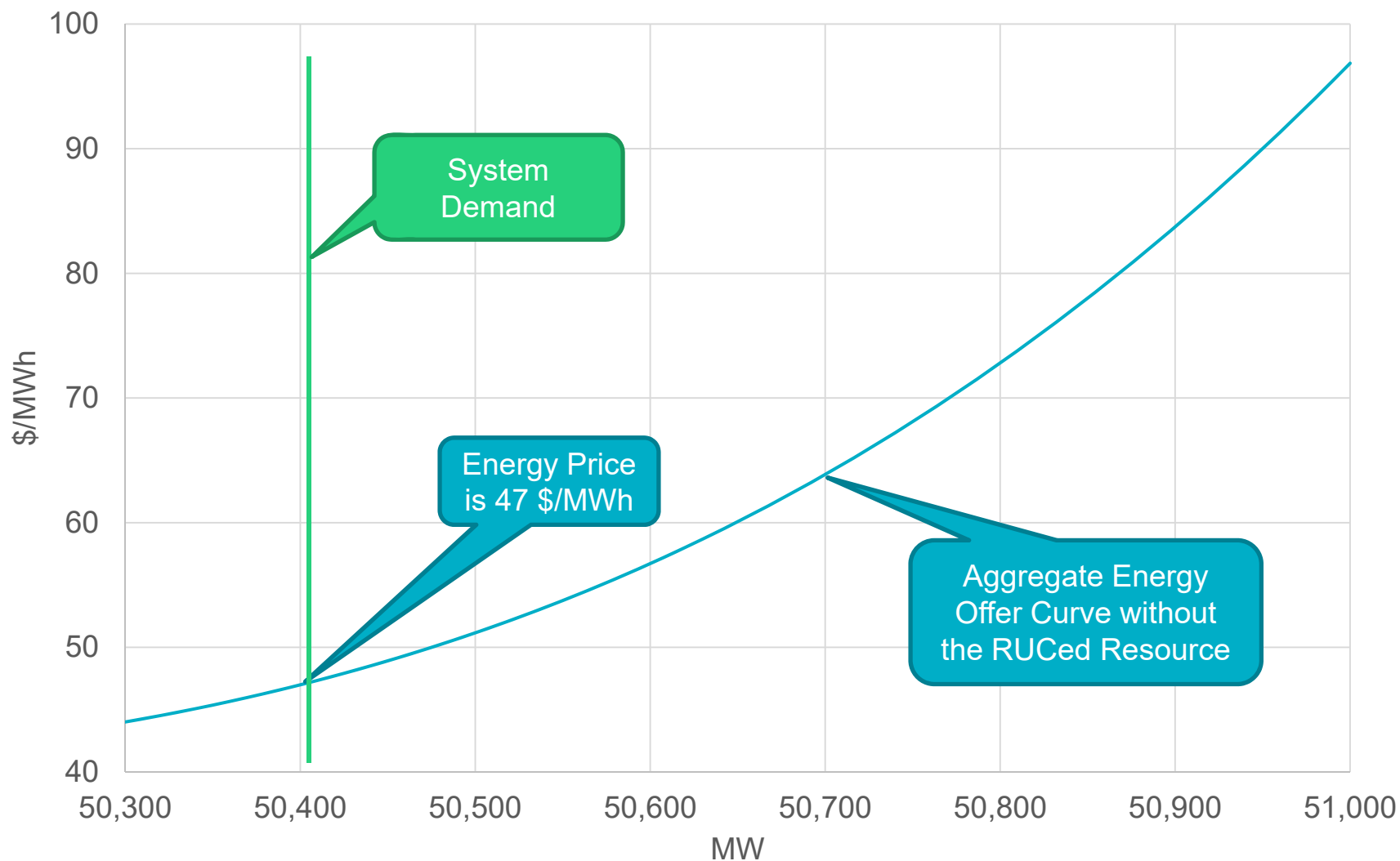> Additional types of reliability deployments will be added as part of Nodal Protocol Revision Request (NPRR) 768
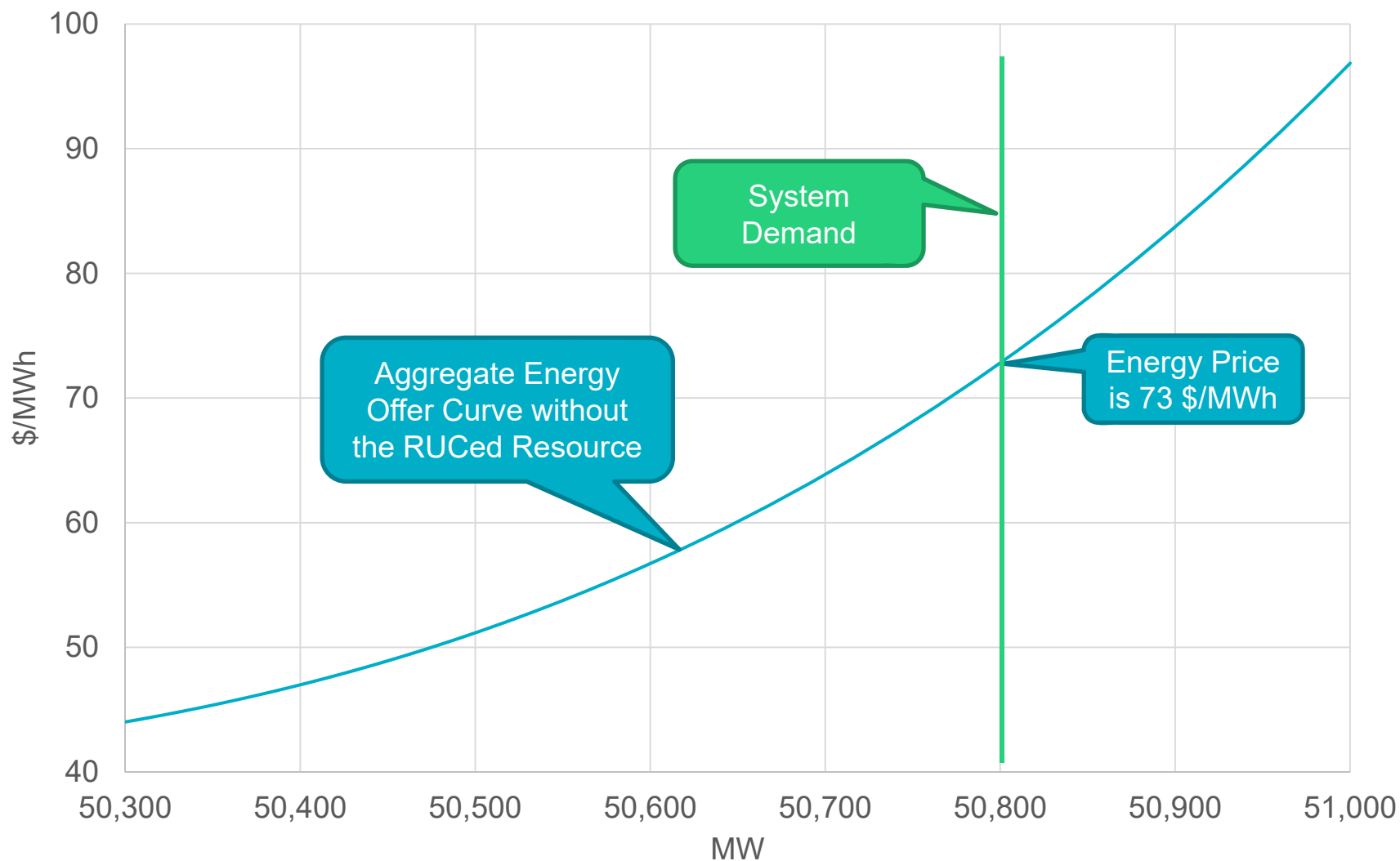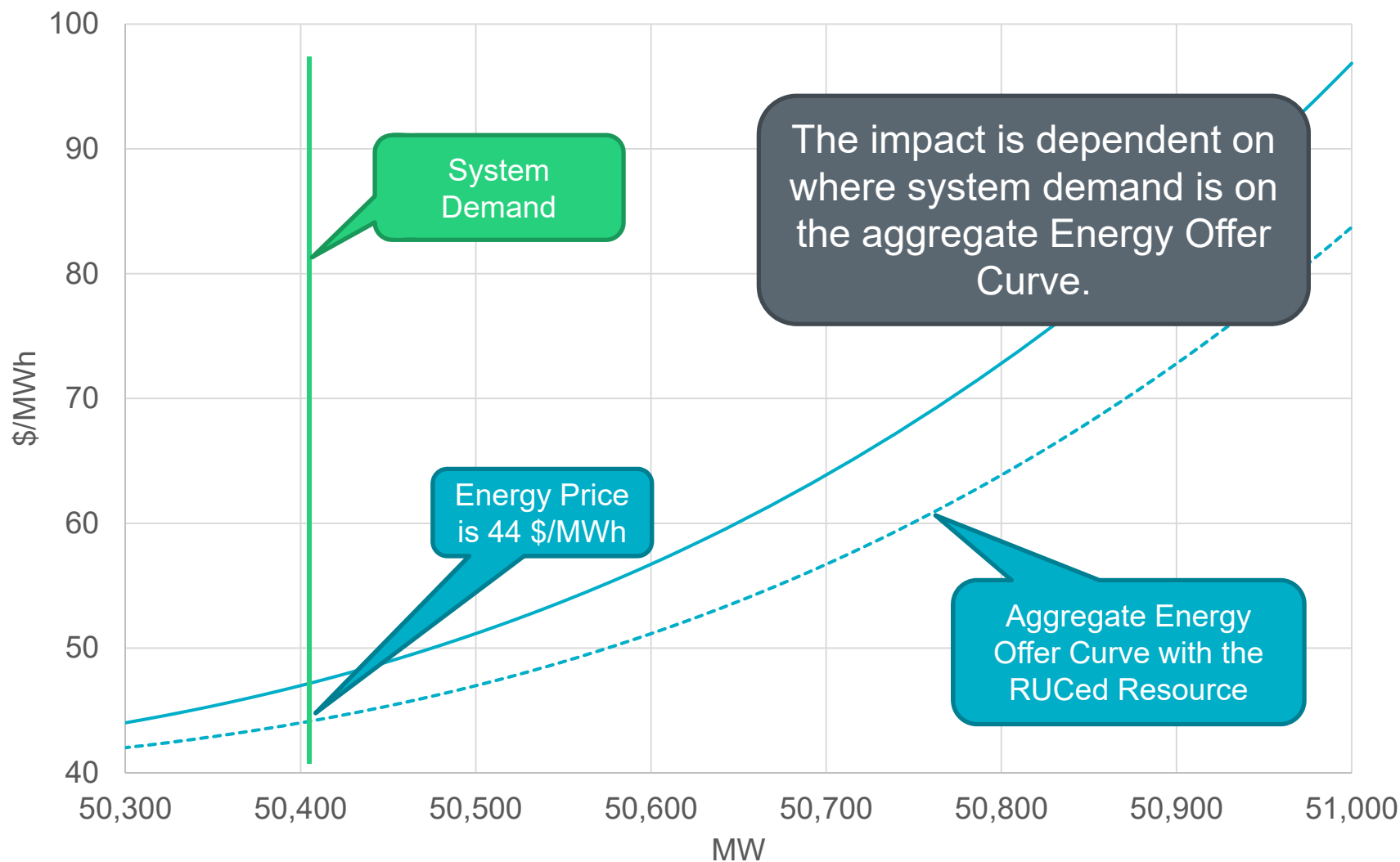
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One Example of Price Suppression - RUCs

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One Example of Price Suppression - RUCs

The aggregate curve shift is driven by the "0 – LSL" energy from the RUC-committed Resource.

System Demand

Aggregate Energy Offer Curve with the RUCed Resource

Energy Price is 64 $/MWh

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One Example of Price Suppression - RUCs

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One Example of Price Suppression - RUCs

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Another Example of Price Suppression – Load Resource Deployment

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Another Example of Price Suppression – Load Resource Deployment

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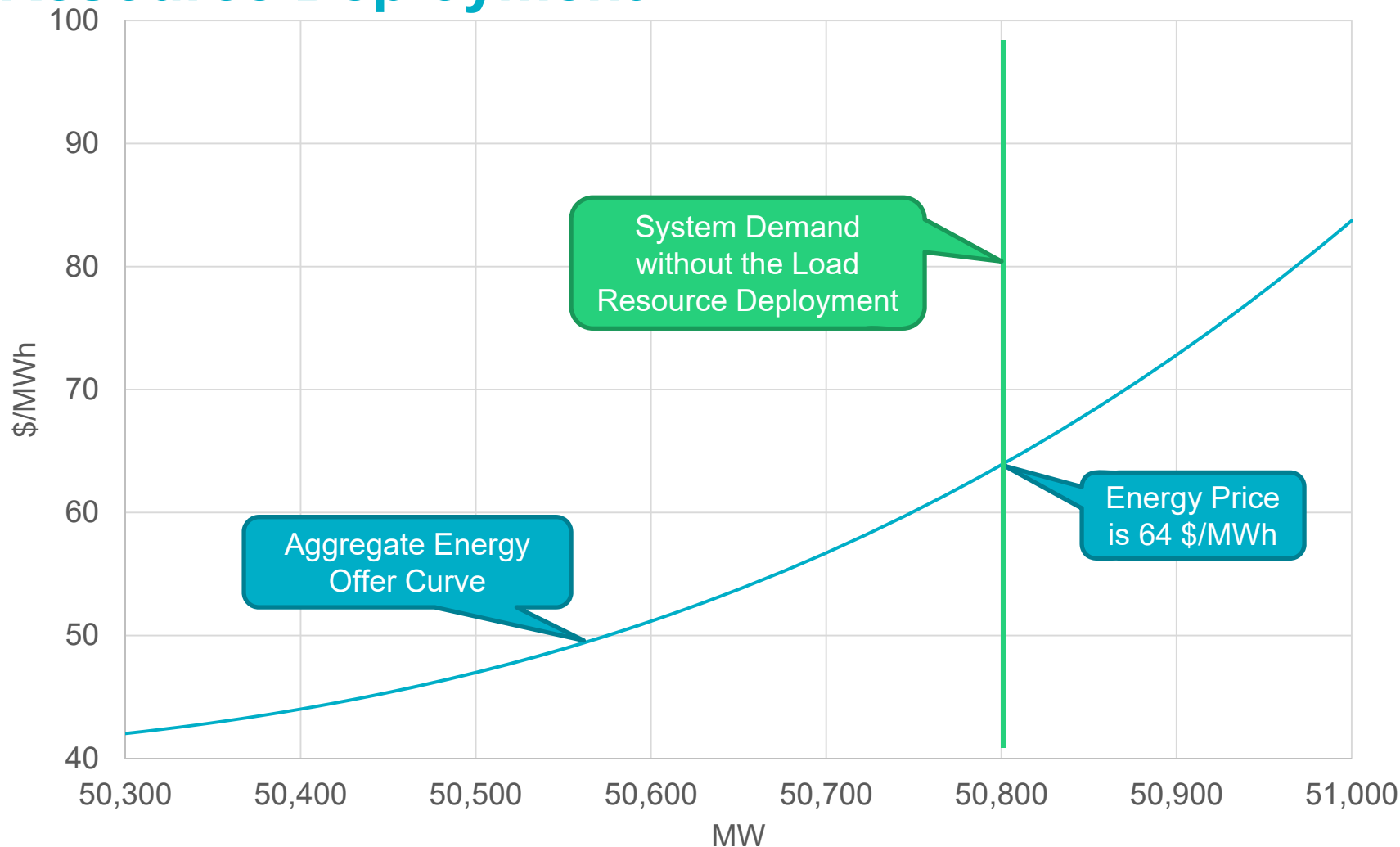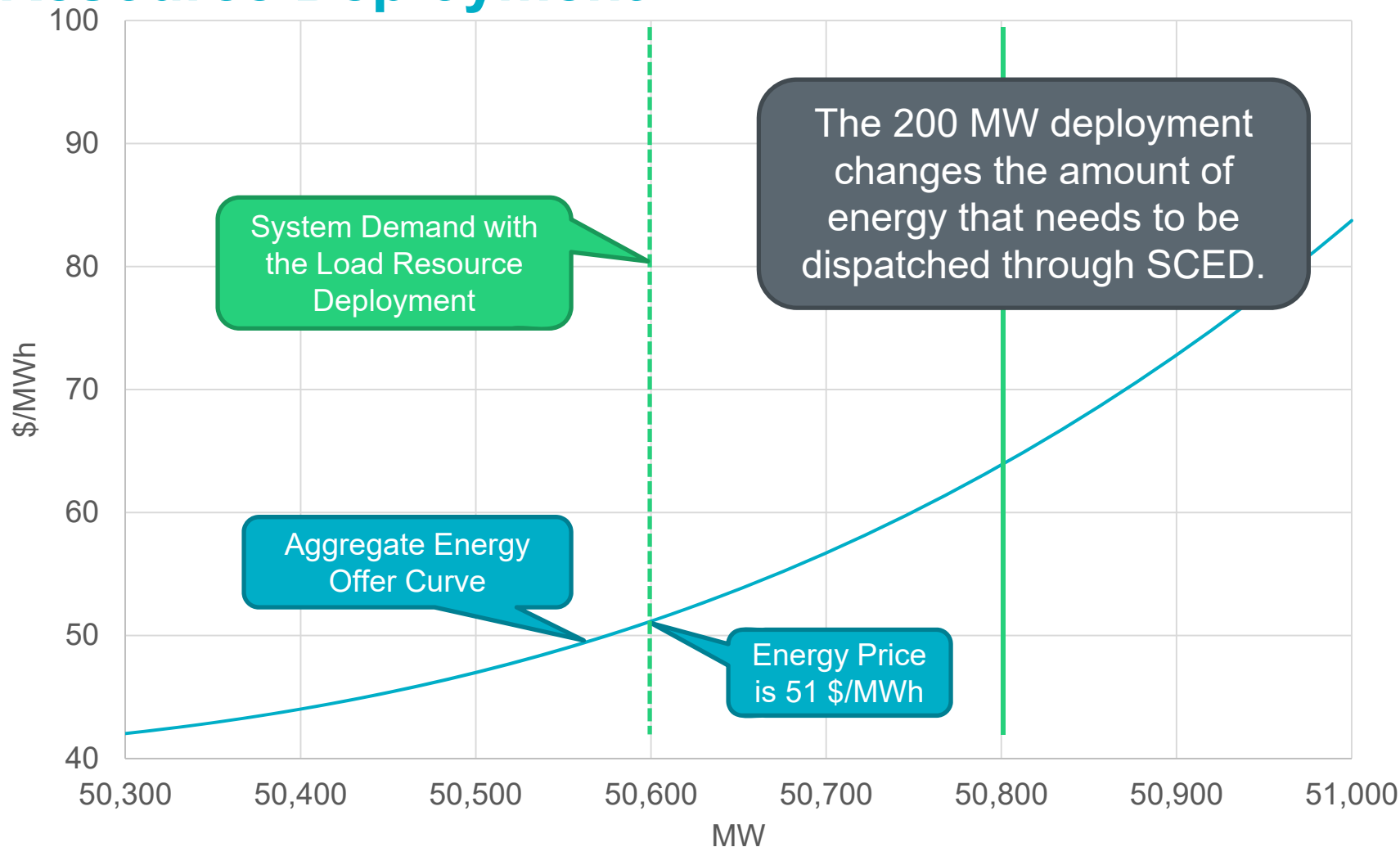
The Reliability Deployment Price Adder

- The RTORDPA was implemented on June 1, 2015 to counteract the price suppressing effect of reliability deployments.

- This effect is estimated by executing the SCED process a second time with the inputs changed to simulate the scenario in which the reliability deployments hadn't taken place.

  – The impact is calculated by taking the difference between the System Lambda resulting this second execution of the SCED process and the System Lambda from the first execution of the SCED process (before the inputs were changed)

Back to the Real-Time Pricing Methodology

- Like the reserve price adders, the RTORDPA also needs to be incorporated into the SPPs
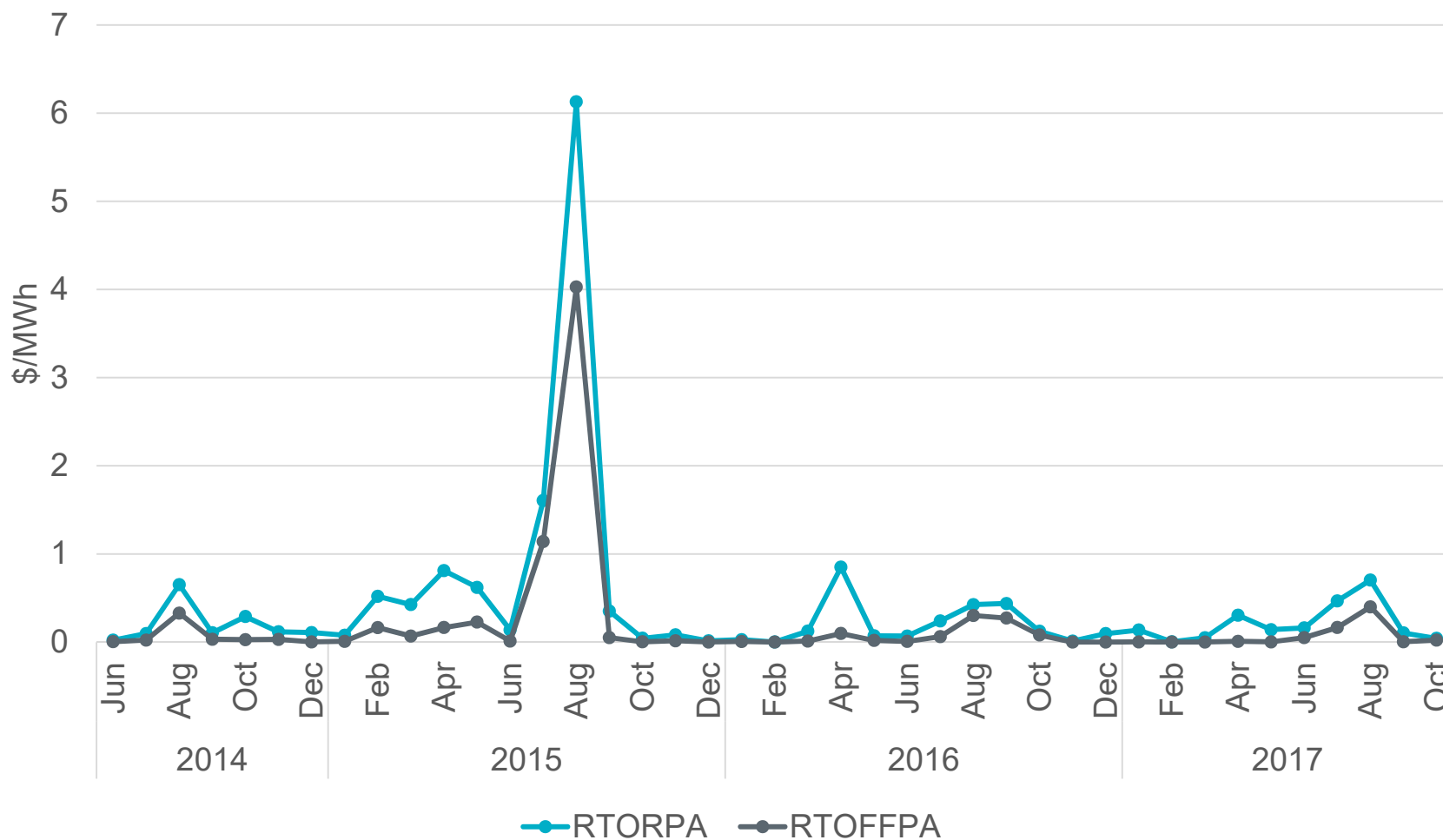
Settlement Point Prices
= Avg. LMPs +
Avg. RTORPA +
Avg. RTORDPA

- RTORDPA is also applied ERCOT-wide.

RTORDPA does not account for the potential local impacts of reliability deployments.

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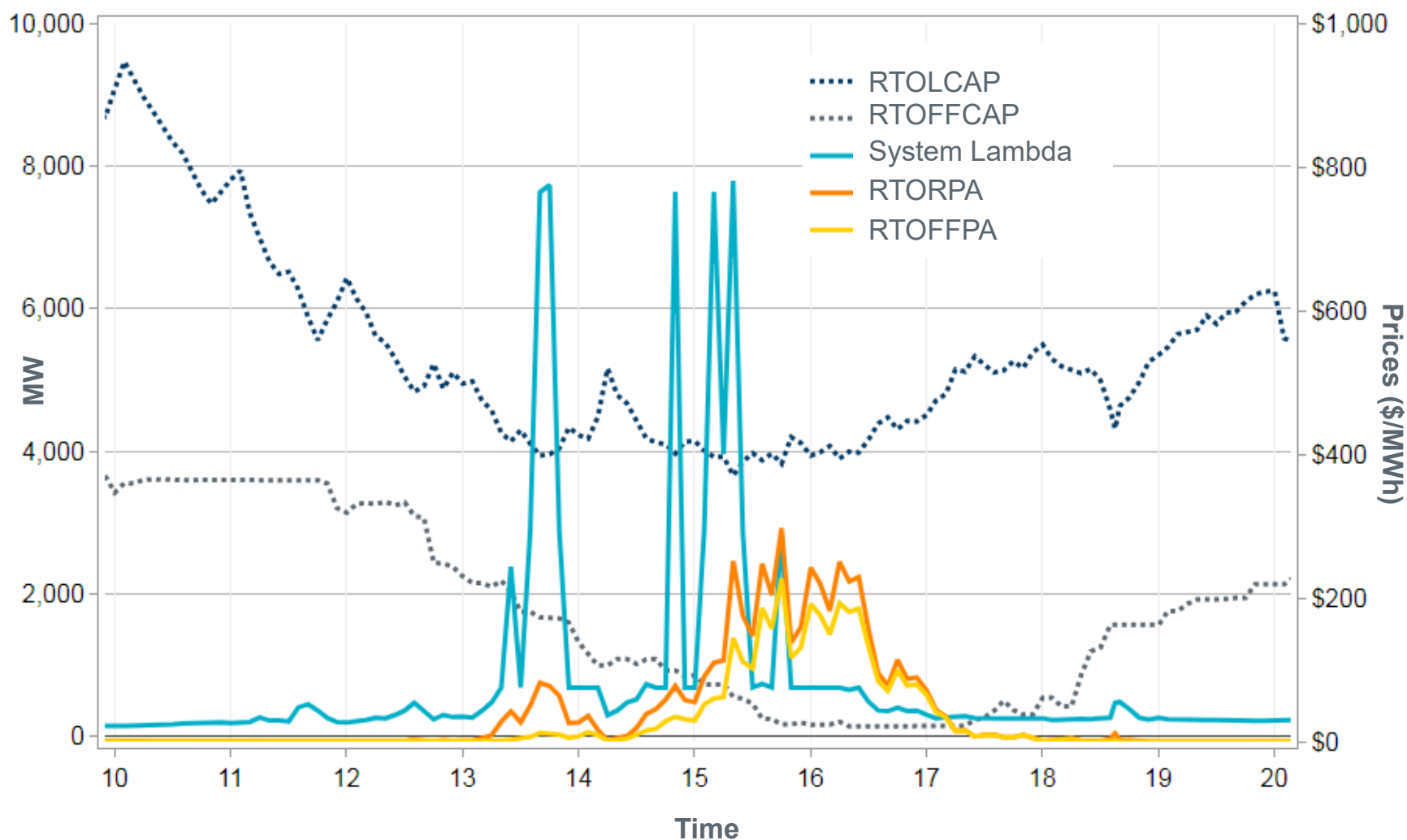# Historic Results – Reserve Price Adders

Average Monthly RTORPA and RTOFFPA Since ORDC Implementation

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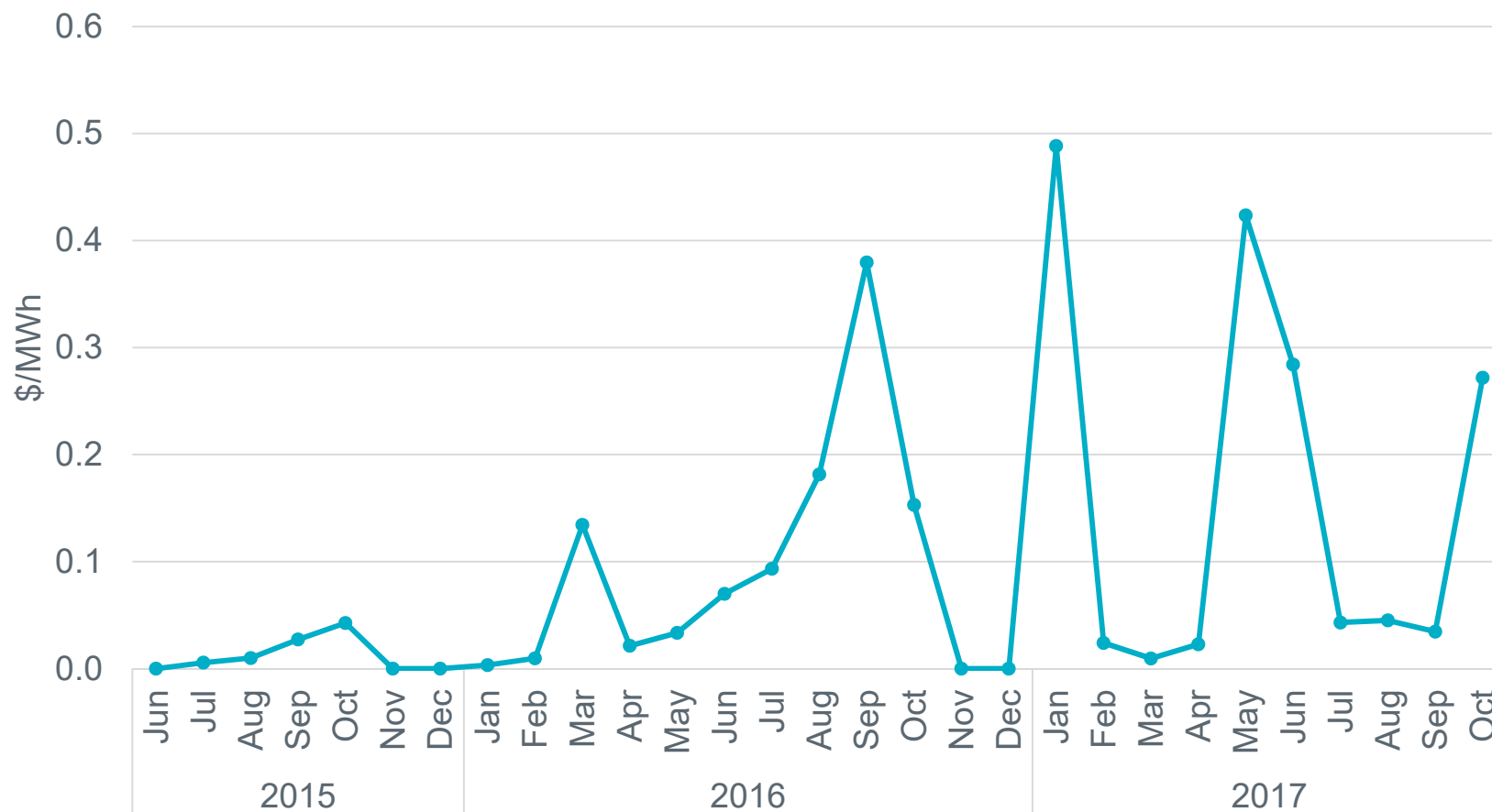
Summer 2017 On-Line Reserve Price Adders

Real-Time Online Reserves and Price Adders for Hours Ending 15 through 18 June - August

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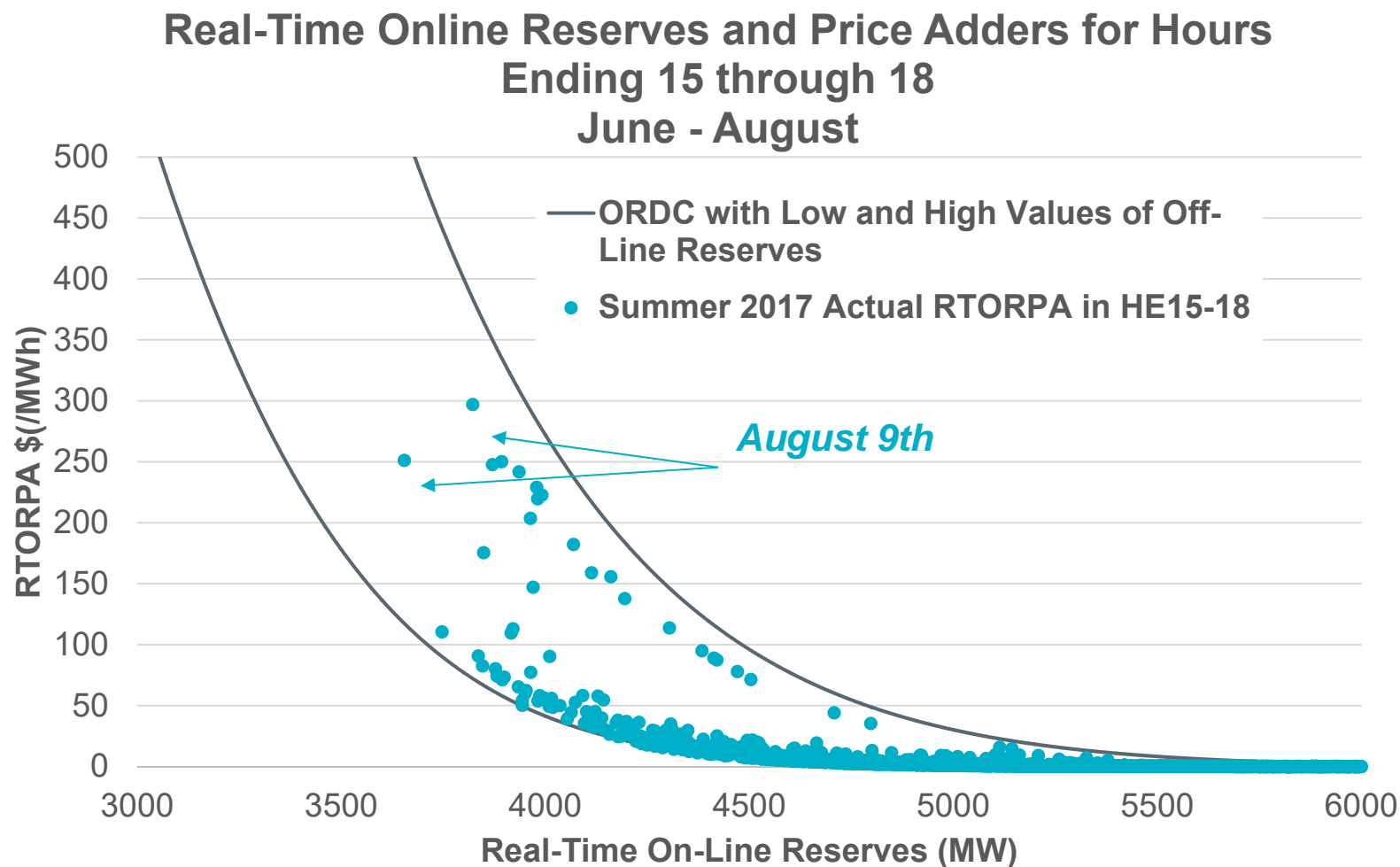
A Closer Look at August 9th, 2017

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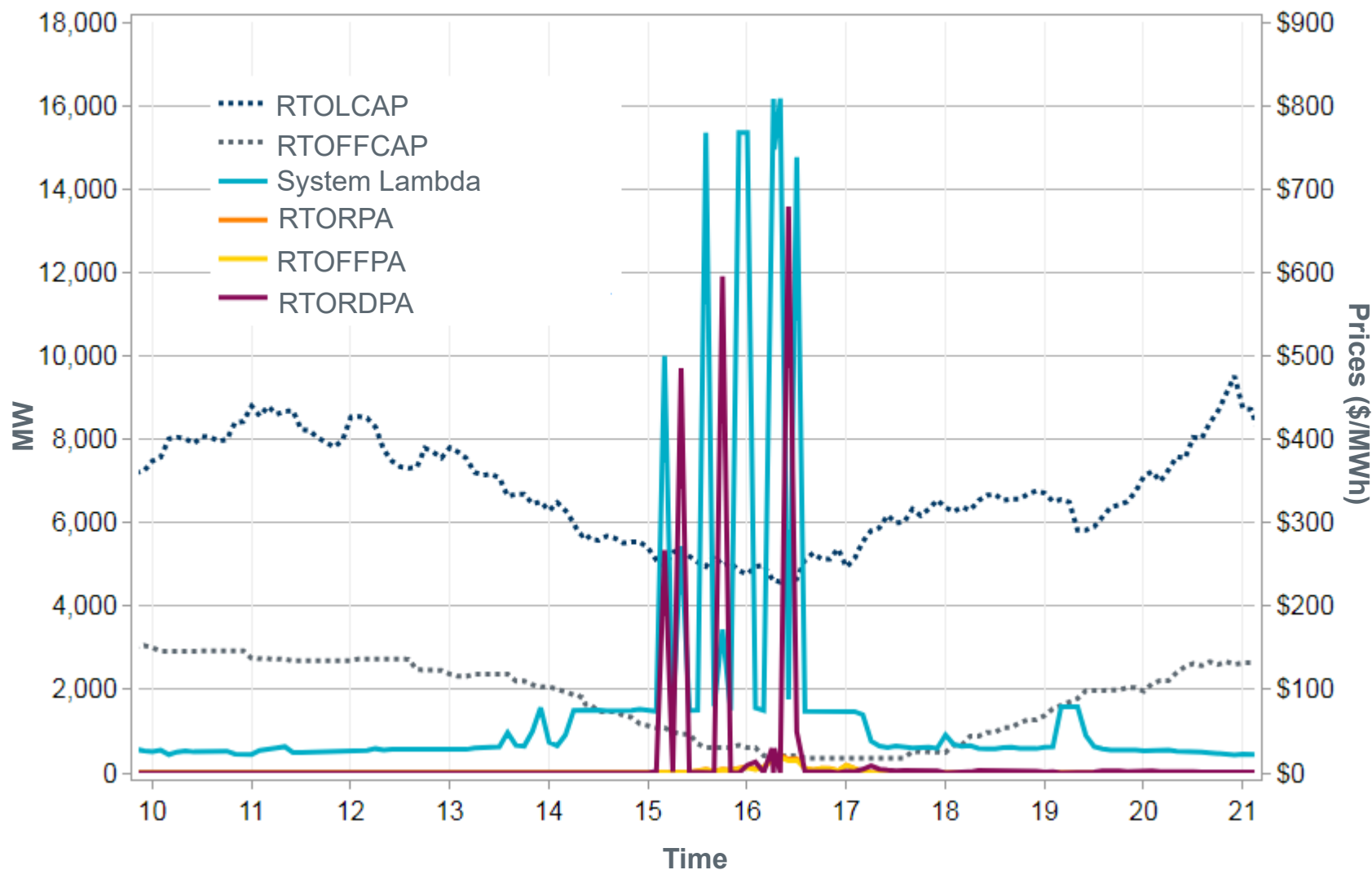# Historic Results – Reliability Deployment Price Adders

Average Monthly RTORDPA Since Implementation of the Change

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A Closer Look at October 4ᵗʰ, 2017

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1. Describe how the operating reserve and reliability deployment prices adders are incorporated into real-time prices

2. Explain the purpose of the prices adders

3. Recognize system conditions under which there is a potential for non-zero price adders

4. Identify what the historical, typical prices adders have been

Questions?

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